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ORIGINAL ARTICLE

Technique for laparobotic distal pancreatectomy with preservation of spleen

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Abstract Minimally invasive surgery for pancreas has advanced at a steady pace in recent years. Although proximal pancreatic resection is still a formidable task, distal resection has become routine with a laparoscopic approach. The recent introduction of the Da Vinci Robotic Surgical System has helped to make this complex procedure much more feasible, efficient, and safe. In this paper, we describe our technique for robot-assisted distal pancreatectomy with splenic preservation, which can be broken down into five steps in a medial-to-lateral progression. Preservation of splenic vessels is routine, although in certain instances a Warshaw's technique is employed. The advantages of the robotic approach are described.

Keywords Robotic pancreatic surgery · Distal pancreatectomy with splenic preservation · Laparobotic · Distal pancreatectomy

Introduction

As with adrenalectomy, minimally invasive surgery (MIS) for distal pancreatectomy has slowly replaced the open surgery approach, as shown by the recent increase in publications on this topic [1–9]. Although laparoscopic pancreatectomy continues to be the most common approach [1–8], it has increasingly been challenged by the much more sophisticated, albeit costly, robotic surgery. We began incorporating robotic surgery into our practice as early as 2001 and have since had considerable experience in pancreatic surgery. At present, all of our left pancreatectomy is done robotically. We present here our technique for splenic preservation distal pancreatectomy; this procedure is indicated in patients with benign or low grade malignant tumors of the pancreas.

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Positioning of the patient (Fig. 1)

The patient is placed in an oblique 30° right lateral position supported by a pillow or a roll of linen sheet behind the left mid back. Both arms are tucked along the body. Before docking of the robot, the operating table may have to be adjusted accordingly. For a proximal pancreatic lesion, the table is placed in a 30° reverse Trendelenburg position to allow the transverse colon to fall down toward the pelvis. For a tail lesion, the table is tilted another 15° to the right and 30° in a reverse Trendelenburg position.

Establishment of pneumoperitoneum

We generally prefer the left subcostal approach using a Veress needle technique. However, in a patient with previous left upper abdominal surgery, we place a 12 mm trocar using Hassan's technique 3–4 cm to the left of the umbilicus.

Trocar placement (Fig. 1)

Choosing placements for trocars is flexible and adjustable according to the patient's body habitus, location of the lesion, and the extent of dissection and/or resection. In general, we use four robotic trocars, and 5 and 12 mm accessory ports. The camera port is placed 3–4 cm to the left of the umbilicus, the left instrument port is on the left lateral

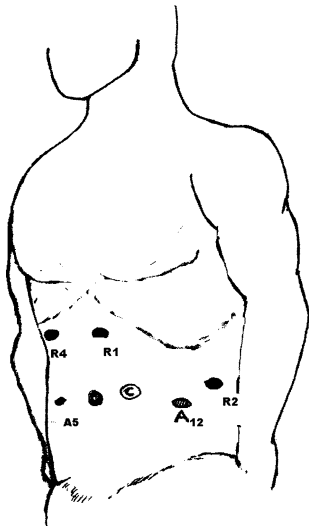

Fig. 1 Positioning of patient

abdomen along the anterior axillary line at the umbilicus level, the right instrumental port is on the right upper abdomen along the pararectal line 3–4 cm above the umbilicus, and the fourth instrumental port is placed along the right midclavicular line at the same level as the right instrument port. A 12 mm accessory port is placed between the camera port and the left instrument port but at 4–5 cm lower. A 5 mm accessory port is placed on the right abdomen in a mirror image to the 12 mm accessory port.

The surgical cart is brought in from the left toward the patient's shoulder. The fourth arm is positioned on the robot's right (surgeon's left). The robot left (surgeon's right) arm holds a monopolar cautery hook, the right arm bipolar forceps, and the right fourth arm grasper forceps, respectively.

Technique

Step 1: exposure of the pancreas

Using the grasper forceps, the anterior wall of the midbody stomach is grasped close to the greater curvature and lifted cranially to create space in the lesser sac. The gastrocolic ligament (omentum) is then divided below and along the gastroepiploic arcade from the prepyloric antrum to the fundus, leaving the short gastric vessels intact (Fig. 2). When the lesion is located close to the neck, right-sided dissection is carried out until the right gastroepiploic vessels and the duodenum are fully exposed. Complete mobilization of the splenic flexure is done unless there is a possibility of en-bloc resection of splenic vessels (Warshaw's technique), in which case the splenocolic ligament is preserved to avoid devascularizing the lower pole of the spleen.

Fig. 2 *Step 1*: exposure of the lesser sac

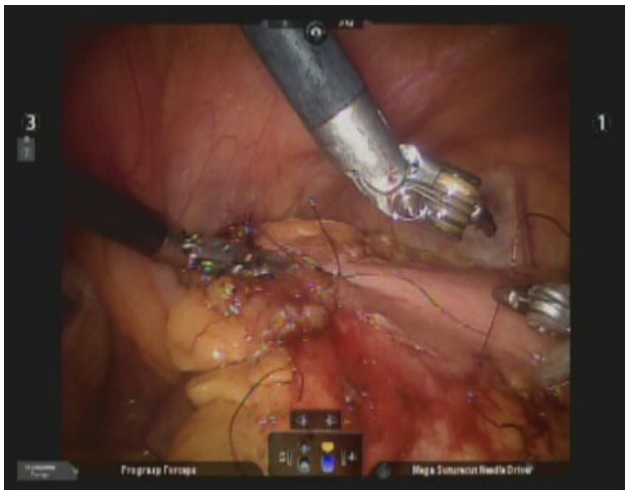

Fig. 3 Tagging of stomach to provide fixed exposure

The pancreatogastric fold (ligament) is next divided to fully expose the pancreatic body. Care is taken not to injure the left gastric vein.

At this stage, in order to maximize the utilization of the fourth arm, the stomach is tagged to the falciform ligament to free up the instrument and stabilize the exposure of the operative field (Fig. 3).

An intraoperative ultrasound of the pancreas, using an 8 MHz laparoscopic probe, is performed if the lesion is small and in the proximal pancreas. Ultrasound images can be displayed in the surgeon console using the TilePro system.

Step 2: mobilization of the pancreas

The transverse mesocolon is stretched downward to define the lower border of the pancreas. The peritoneum overlying the border is then incised and the loose areolar tissue plane behind the pancreas is entered. The pancreas is gently

Fig. 4 Posterior dissection of pancreas (*SV* splenic vein)

Fig. 5 Dissection of splenic artery (*SA*)

lifted and rotated upward and held in place by the fourth arm grasper forceps while the dissection is carried out cranially and laterally. The splenic vein is identified about halfway to two-thirds from the lower border (Fig. 4). In some patients, the tortuous (looping) part of the artery may be found right after the vein, and is used to guide the upper border dissection. In this way the pancreas can be mobilized circumferentially just from the posterior approach. In general, however, an anterior approach from the upper border of the pancreas is preferred to isolate and control the artery (Fig. 5).

Extent of pancreatic mobilization

Proximally, the pancreas is mobilized up to the portosplenic junction (Fig. 6). However, this extended dissection may not be necessary if the lesion is confined to the tail and as long as a margin of 2–3 cm is achieved.

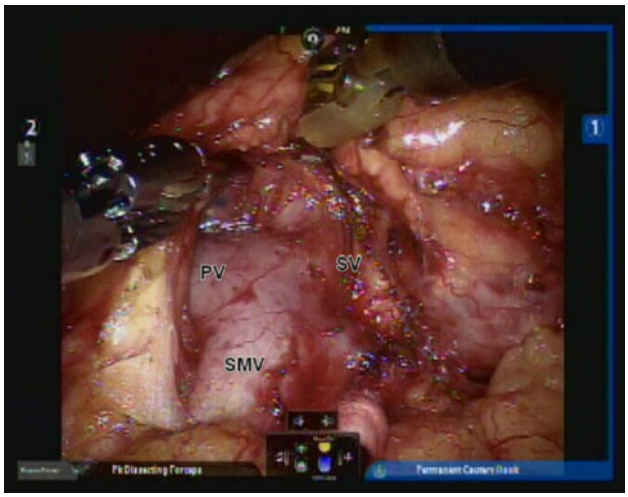

Fig. 6 Extended dissection of portosplenic junction (*PV* portal vein, *SV* splenic vein, *SMV* superior mesenteric vein)

Knowledge of the relationship between the pancreatic tail and spleen from preoperative imaging facilitates the distal dissection. In some patients, short or absent pancreatic tail creates a wide gap, while in others the tail may fit closely to the splenic hilum. In the latter case, the splenic flexure may have to be completely detached from the spleen in order to safely free the tail from the hilum.

Step 3: pancreatic transection

After the pancreas is freed posteriorly, our preference is to divide the pancreas first and then separate it from the splenic vessels toward the tail. Two techniques are used depending on the thickness of the pancreas and the success of vascular separation from the pancreas at the transection site. If the pancreas can be dissected free from the vessels and is thin, an endo-GIA stapler is used (Fig. 7). The stapled proximal stump may need to be reinforced with 3-0 prolene suture if there is bleeding.

If the pancreas cannot be easily dissected away from the vessels or is too thick for the stapler, then it is divided directly with a combination of cutting, cauterization, and suture ligation (Fig. 8). Since the vessels are partially exposed, they can be seen and protected at all times during the process. The proximal stump is closed using a running 3-0 prolene suture and then covered with fibrin glue. If the pancreatic duct is visible, it is first transfixed with 5-0 PDS suture.

Step 4: separation of pancreas from the vessels: medial-to-lateral approach

After the pancreas is transected, its distal stump is grasped and carefully retracted laterally while it is dissected off from the vessels (Fig. 7). There are three or four short

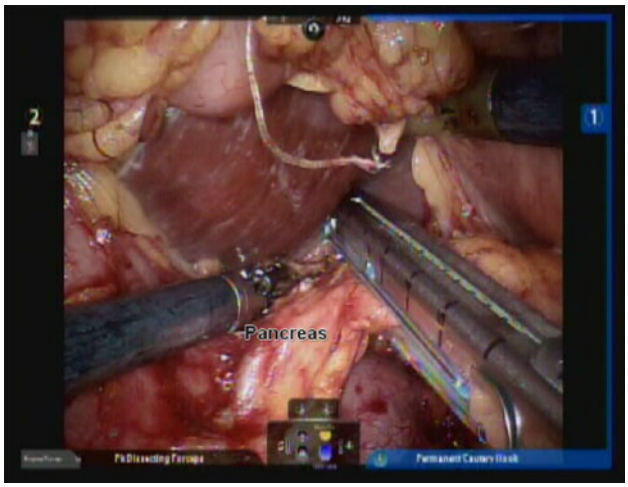

Fig. 7 Pancreatic stapling transection

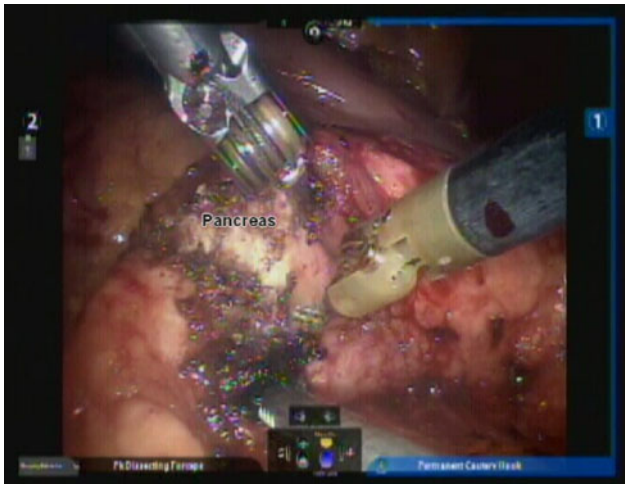

Fig. 8 Manual pancreatic transection

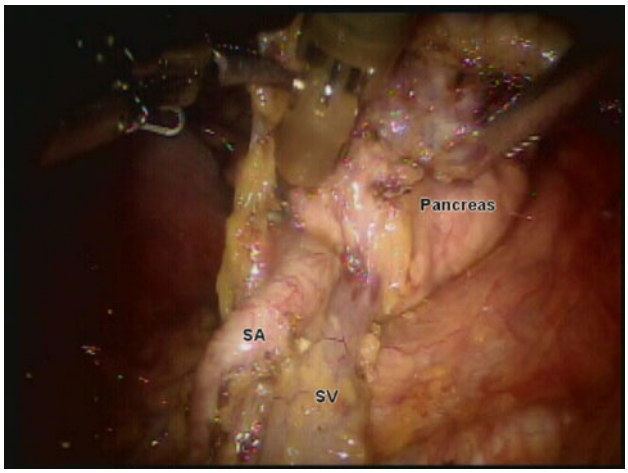

Fig. 9 Dissection and mobilization of pancreas at the C-loop portion of splenic artery (*SA*). *SV* splenic vein

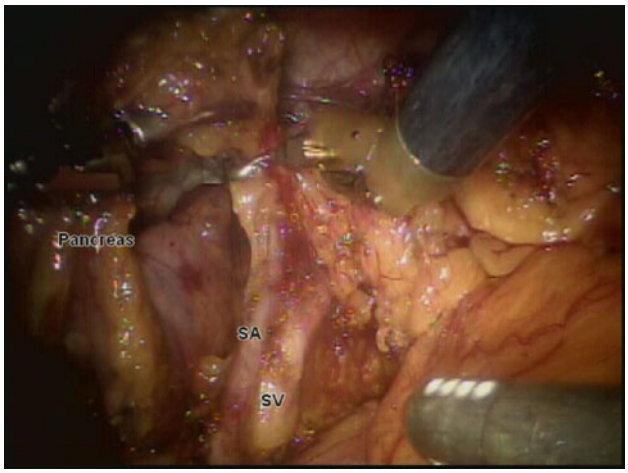

Fig. 10 Dissection of the pancreatic tail (*SA* splenic artery, *SV* splenic vein)

crossing vessels into the pancreatic body that require meticulous dissection before they are ligated with 4-0 silk sutures and divided. Stay sutures may be placed on the stump to allow for easy manipulation of the pancreas. The intelligent use of the fourth arm to hold and stabilize the pancreas during the dissection makes the process much more efficient and safe. During the dissection and mobilization, there are two areas requiring particular attention. The first area is at the looping portion of the splenic artery (Fig. 9). Here, it is important to dissect along the curvature of the artery while paying careful attention to the medially located splenic vein. Occasionally, a drainage vein may be encountered exactly where the artery is in close approximation to the splenic vein. The second area is around the tail of the pancreas (Fig. 10) where several drainage vessels may be found clustered together and can be easily injured.

The lateral-to-medial approach is used when the lesion is at the tail. As mentioned earlier, for this approach the splenic flexure has to be completely separated from the spleen so that the latter can be mobilized laterally away from the pancreatic tail, which is retracted medially and downward. The pancreas can be divided once a margin of at least 2 cm from the lesion is achieved.

Warshaw's technique is used in cases with significant inflammatory reaction between the pancreas and splenic vessels and/or small spleen. A medial-to-lateral approach, in which splenic vessels toward the portal vein are divided first, is employed.

Step 5: specimen extraction

The resected pancreas is placed in the endobag which is brought out through the enlarged 12 mm accessory port incision. After adequate hemostasis is confirmed, a

closed-suction drain is placed in the pancreatic bed and brought out through the left instrument port incision.

Discussion

Compared to laparoscopic surgery, the robotic approach has several advantages well described in the literature. The most commonly cited advantage is that it brings the open surgery "feeling" or "experience" to the minimally invasive environment by providing the surgeon with intuitive hand–eye coordination, 3D vision, and dexterity enhancement. However, regardless of which access method or instrumental system a surgeon may choose, the basic technical approach to the procedure is similar. It has to follow the sequential steps of exposing, dissecting, mobilizing, and then resecting the target organ. These steps can be made efficient and safe provided that a surgeon is aware of the disease process and knowledgeable about the topographic anatomical relationship of the diseased organ to the surrounding structures. Unlike pelvic or hiatal surgery, positioning of the patient and trocars are varied depending on the size of the patient and the location of the tumor. Careful study of preoperative images is therefore crucial not only in the formation of mental 3D images of the operative field but also in the planning for placement of trocars, positioning of patient, and locating the robot (surgical cart) position in relation to the operating table.

There are three important anatomical components that help to guide the exposure and dissection: ligaments, blood vessels, and the tissue plane. In open surgery, a surgeon uses both visual and tactile senses to guide the dissection, whereas in robotic surgery they can only depend on visual guidance. Recognition of the tissue plane is therefore essential for safe dissection and, fortunately, is enabled by the high-definition 3D imaging and stable visual platform of the robotic system. Experienced pancreatic surgeons who are familiar with manual dissection can readily recognize this plane and may find it not too difficult to replace their tactile feedback with visual cues.

Although the laparoscopic technique for distal pancreatectomy with or without spleen preservation has been well described in the literature [1–8], there have been few [9], if any, detailed descriptions of the technique of spleen-preserving distal pancreatectomy using the Da Vinci Robotic System. Our technique has been developed through our own experience; it by no means represents a standard technique. Like the old saying "there are many ways to skin a cat", each individual surgeon may have their own technique which suits them perfectly as long as the outcome is good. However, we can learn some tricks here and there from one another to improve our own technique, so that we can all achieve the same ultimate goal: a safer and more efficient technique for our patients.

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